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MANUFACTURING CAPABILITIES OF KEY SECOND-TIER DEFENSE INDUSTRIES

HEARING

BEFORE THE

SUBCOMMITTEE ON
DEFENSE INDUSTRY AND TECHNOLOGY

OF THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

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MANUFACTURING CAPABILITIES OF KEY SECOND-TIER DEFENSE INDUSTRIES

THURSDAY, JULY 23, 1987

U.S. SENATE,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON DEFENSE INDUSTRY AND TECHNOLOGY,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:10 a.m., in room SR-222, Russell Senate Office Building, Senator Jeff Bingaman (chairman) presiding.

Present: Senators Bingaman, Dixon, and Warner.

Staff present: Andrew S. Effron, counsel; Gerald K. Bankus, Jonathan L. Etherton, and Richard D. Finn, Jr., professional staff members; and Kathleen L. McGuire, staff assistant.

Also present: Edward M. McGaffigan, Jr., assistant to Senator Bingaman; Charles C. Smith, assistant to Senator Dixon; Alan Ptak, assistant to Senator Gramm; and Samuel J. Routson, assistant to Senator Symms.

OPENING STATEMENT OF SENATOR JEFF BINGAMAN, CHAIRMAN

Senator BINGAMAN. Let me just go through a short opening statement, and then I would like to insert a statement by Senator Dodd. I do not know if Senator Gramm will be here, but if by the time I finish he is here he can give a statement. Otherwise we will go ahead.

This morning the Defense Industry and Technology Subcommittee continues its hearings on the subject of the health and vitality of the defense industrial base.

The subcommittee received testimony earlier this year in broad terms on the technology base, the industrial base and on recent changes in the acquisition process and the effect of those changes on both the technology and industrial base.

The central thread running through the hearings we had earlier was that the underpinnings of defense, that is the industrial base and the technology base, are deteriorating. Furthermore, the erosion in these two critical areas was accelerating as a result of some of the problems we have created in the acquisition process.

Our hearings, as well as increased commentary in the media, debate here in Congress and charges by the industry have pointed to the differences in industrial and trade policies between our country and some of the other nations that we trade with.

Oftentimes we focus on major weapon systems issues affecting first-tier American firms as we did the other day. Tuesday we

voted 96-0 to urge the Japanese Government to purchase an American aircraft for its follow-on fighter.

The real problems perhaps with our defense industrial base may lie more in our second and third-tier defense manufacturers. Offset arrangements entered into by first-tier American defense firms and foreign government preferences for their domestic manufacturers in their defense acquisitions directly affect the viability of many lower tier American manufacturers.

Since innovation in those industries, which produce the building blocks for our weapons systems, is critical to our long-term ability to maintain a qualitative advantage over our potential adversaries, we need to focus attention on the problems these lower tier firms face and try to come up with constructive solutions to them.

Earlier this year we focused on a lower tier industry, the semiconductor industry, because a Defense Science Board study had recommended that DOD was requesting significant funding for a semiconductor manufacturing technology institute, or Sematech.

Today we will hear from representatives of three other second-tier industries: machine tools, ball bearings, and precision optics. Among other things we will be updated on another manufacturing technology consortium, the National Center for Manufacturing Sciences, to which the Department of Defense is contributing.

But before we hear from the industry representatives, in order to put a perspective on the issues confronting these industries in the international market, we are going to receive testimony from Dr. Clint Kelly of the Defense Advanced Research Projects Agency.

He will present the result of a management assessment team review of Japanese industry, and hopefully introduce his recommendations for improving the competitiveness of American industry. Dr. Kelly is currently the special assistant for Strategic Computing at DARPA.

At the conclusion of his testimony we will ask a panel of industry experts to join Dr. Kelly at the witness table. We will introduce the panel as we ask them to come forward. But let me first go ahead with Dr. Kelly.

Dr. Kelly, we welcome you this morning. We recognize you have been extremely busy, and we appreciate the time you are spending with us. The topic you are addressing is timely, and one which continues to capture the attention of a growing number of concerned Americans. We appreciate your willingness to testify this morning. So why do you not go right ahead and give us whatever testimony you have prepared.

STATEMENT OF DR. CLINTON W. KELLY III, SPECIAL ASSISTANT TO THE DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Dr. KELLY. Thank you, Senator Bingaman. It is a pleasure and an honor to appear before this committee and to summarize for it the observations of the Department of Defense's Technology Assessment Team on Japanese manufacturing technology.

I would like to introduce three members of the Technology Assessment Team who are present. Dr. Parrish on my left from DARPA, Dr. Russo from the Air Force Aeronautical Lab, and Mr.

Tupper from the Air Force Aeronautical Lab. I would hope that they would be able to answer questions in their particular areas of expertise.

If I may, I would enter my testimony into the record and then just summarize it to make better use of the committee's time.

Senator BINGAMAN. That is fine.

Dr. KELLY. To begin, I believe there is no single adequate explanation for Japanese manufacturing effectiveness.

The ability of the Japanese to deliver the right product at the right time at the right price, with high quality, flies in the face of some of the books that one can acquire these days which suggests that if you only do one particular thing you will be able to compete with the Japanese.

I think the issue is substantially more complex. I believe that their manufacturing performance and effectiveness is rather a function of many interacting variables.

For ease of discussion I have broken this into four categories. The techniques that they use to achieve rapid commercialization of new technologies and the products, the nature of their manufacturing enterprises, the human resources, and quality.

With respect to rapid commercialization, I believe there are five factors one can identify which contribute to the speed with which they introduce new products into the marketplace.

The first is the role which MITI, the Ministry of International Trade and Industry plays in setting a strategic direction. MITI sets up consortia or joint ventures and makes available financing, provides some measure of protection in the domestic marketplace against imports in designated areas where they are trying to develop new capabilities.

The goal of MITI, however, is not to eliminate competition, but rather to encourage and protect Japanese companies until they can compete with one another domestically and compete in the international marketplace.

Dr. James Obligen, formerly with the Boston consulting group who has written extensively on Japan, calls this Darwinian economics after a belief that when many Japanese companies have reached a certain level of capability, they compete fiercely against one another for shares of the domestic marketplace.

And the survivors, who then enter the international marketplace, are quite aggressive, quite lean, and quite efficient.

The second factor contributing to rapid commercialization is the company's product development philosophy. They give responsibility in many Japanese companies to autonomous product development teams who operate under broad guidance with the total support of top management.

These teams develop an entrepreneurial outlook that is highly motivating, but would otherwise be difficult to achieve within the more structured operation. Now, in the large organization, a significant factor is that these teams contain representatives from all elements of a corporation that would have an interest in the product throughout its life cycle.

So a team will contain personnel for marketing, from design, for manufacturing, field support, and notably from principal vendors

who are suppliers. These product teams proceed with the design process by overlapping several phases of development.

And this arises rather naturally from the multifunctional makeup of the team, in contrast with procedures used in many U.S. companies, particularly defense contractors, in which development proceeds sequentially. The advantage of the Japanese approach is that it allows development time to be substantially compressed.

The third factor contributing to rapid commercialization is a series of technologies that the Japanese use, generally grouped under the heading, design for automated assembly, sometimes called design for manufacturability.

The objective of this body of practice is to reduce the number of parts contained in a design, to try and use as many common parts and as many standard parts as is possible.

The Japanese are keenly interested in not reinventing things. And if they have a part or subassembly that has worked well, they will try and incorporate that part or subassembly into a new design.

The result of this approach is that you end up with a simpler, more reliable product, one that is easier to manufacture, and easier to assemble with inexpensive, simpler robotic devices, and one that is so designed that it is easier to apply group technology, which is a very efficient means of fabricating parts to the fabrication of those parts.

It also has a tremendous impact on the overhead or above the shop floor charges that one hears so much about. By reducing the number of parts, going to common parts and standard parts, you dramatically impact the number of transactions that occur within a corporation to order parts, to inspect and to inventory them, and to issue them.

And this can have the effect of reducing transaction costs by a factor of two or three, which is a huge element of overhead.

The fourth element in this area of rapid commercialization deals with the so-called hidden strength of Japanese manufacturing, the network of vendors that have been developed by all of the major corporations over long periods of time.

These vendors constitute a large distributed or virtual factory with each vendor having specific areas of expertise that can be called into play to accelerate the development of new products.

It is interesting to note that over 96 percent of all Japanese manufacturing enterprises have fewer than 300 employees and are capitalized in 100 million yen or less. I used to know what that was equivalent to in dollars, but it is changing so rapidly these days I will not try and translate it.

It is also interesting to note that over two-thirds of all the computer numerically controlled machine tools in use in Japan are associated with small and medium-size companies.

Companies adopt, as I mentioned earlier, very long-term relations with their vendors. They cultivate them, they take care of them in hard times. As a consequence, they get extremely high quality products from the vendors.

Oftentimes, the quality is ensured because the prime contractor will have installed quality control people at the vendor site to work with the vendor on developing new process technologies.

In many instances, in our survey of Japanese manufacturers, we found that prime contractors do not do acceptance testing of components derived from the vendors. They just assume they would be of high quality.

Another consequence of this is that the vendors will start very early in the development cycle, again doing development of tooling and fixturing in advance of receipt of completed designs from the prime contractor. And that, again, can rapidly accelerate the process of commercialization, the process of development.

Finally, the Japanese make aggressive use of rapid prototyping of both the product and the process in the development cycle. They believe that if you attain stability in your design, that you obtain stability in manufacturing.

Their philosophy is to get it right the first time, through prototyping of product and process in hardware, rather than thinking it through in great detail on paper. As a consequence of this, they have very few engineering change orders once a product goes into manufacturing.

They have less disruption of the manufacturing process, which results in lower costs, and in the context of rapid commercialization, substantially fewer delays.

As I mentioned earlier, in part you can do this because you have incorporated into your development team representatives from all portions of the manufacturing enterprise.

And many of the difficulties that might be anticipated or encountered in manufacturing have been highlighted in the development process by the manufacturing or the field service members of the development team.

The second area, which I think serves to account for Japanese manufacturing efficiency is the nature of the manufacturing enterprise itself. And there are three perspectives that one can use to view this.

The first is the Japanese view that manufacturing is a strategic factor which is as important in achieving competitive advantage as product design or marketing. They spend a tremendous amount of money on manufacturing technology and research.

In several companies, we received estimates that they spend about 40 percent of their internal research money on manufacturing technology, as opposed to product improvement.

They incrementally and routinely improve their manufacturing facilities, and in doing this are facilitated by access to low-cost capital and by long-term market share focus.

A second way to look at the Japanese manufacturing enterprise is from a materials flow perspective. Japanese factories that we visited in general are designed to work on a flow-through or stockless production basis, with each stage of the manufacturing process producing only the amount of material required for the next manufacturing step.

This means that they have an extremely low work-in-process inventory, which again serves to reduce costs. Perhaps more signifi-

cantly, the control over the entire manufacturing enterprise is simplified.

The most straightforward way to handle planning and scheduling problems is to reduce complicated material flow. Nowhere in Japan did we find the complicated production controlled processes, production controlled software with the associated overhead costs that are typical in United States factories. The Japanese just do not seem to require them.

The third perspective on the manufacturing enterprise is in terms of the automation that they employ. The Technology Assessment Team went to Japan expecting to see a large amount of automation. And in fact we did.

The surprise was that the robotic devices we encountered in most factories were substantially less sophisticated than we had anticipated.

While the Japanese have approximately 40,000 robotic devices installed in their factories, versus some 10,000 in the United States, depending upon the definition one chooses to employ, most of the robotic devices were characterized by a few degrees of freedom.

They are the so-called SCARA robot type device. It has about four degrees of freedom, contrasted with far more——

Senator BINGAMAN. What is that kind of device again?

Dr. KELLY. It is a robotic device that moves essentially in a single plane, and can insert parts from a vertical direction.

It is interesting how they design their products to utilize those type of devices. In a lot of manufacturing enterprises in the United States, the designers design the product. It then goes to manufacturing, and manufacturing has to develop the technologies to build the product as designed. And that might involve, for example, constructing a device that would rotate the work piece three times, so parts could be inserted, for example, from three different directions.

In Japan, they tend to design products with the limitations of these robotic devices in mind. So a Japanese manufacturing representative on the product development team might say to a designer, the way you designed this will require a complicated robotic device. Can you go back and design it so that we can use the rather simple device that we have got?

And in general, through that negotiation process, the product is redesigned so it can be assembled using, for example, a simple four degree of freedom robotic device. The implication of this is that these simpler robots are less expensive, they are easier to program, easier to maintain, and perhaps more significantly they are easier to reprogram when a new product is introduced.

Another comment on automation is that it is introduced slowly in the Japanese factories and only after substantial study, and its introduction is facilitated by the stockless or flow-through material control philosophy, which tends to highlight areas very obviously where automation might serve to improve productivity.

In the United States, all too frequently, automation is regarded as a purchase product with a beginning, a middle, and an end. Development is left primarily to equipment suppliers and the link between product and process design is lost.

More importantly, because it tends to be presented as is to workers, they do not readily understand how to extract maximum benefit from it. And oftentimes you will have a capital investment not operating at peak capacity for some time until the workers understand how to extract maximum benefit from it.

The important fact, I guess, about the Japanese manufacturing enterprise, was achieved without central computer control, sometimes called computer integrated manufacturing.

And we believe this becomes significant when you realize what the addition of this computer integrated manufacturing or central computer control linking on production equipment could mean.

It might mean that the Japanese are beautifully positioned to make a move that would put them in a world leadership for economical, small batch, mixed mode manufacturing.

The third element in——

Senator BINGAMAN. Let me just ask before you go on, are you saying that by using computer integrated manufacturing, the Japanese can move into a position of leadership in manufacturing overall. Is that the point you just made?

Dr. KELLY. My personal opinion, Senator, is that they have achieved a great deal without using these kinds of technologies.

And if they develop these kinds of technologies, by that I mean the kinds of technologies necessary to integrate all of the elements in a facility under central computer control, that this could position them for a substantial move forward.

I think one needs to examine carefully whether or not they are in possession of the technologies to do this. We saw no evidence in the factories that we visited that they had the technologies necessary to make this happen. On the other hand, we did hear in a number of places that we visited the expressed intent to do it as a next step.

The third factor that I believe contributes to Japanese manufacturing effectiveness is human resources. That effectively underlies everything that they do. To begin, there is a fair amount of prestige associated with a manufacturing career in Japan.

As a consequence, the best and the brightest students are attracted to manufacturing. Japanese factories, as a consequence, have several times as many engineers in the manufacturing enterprise as U.S. factories.

And in a number of the facilities that we visited, all of these engineers have received extensive training in the operation of the computer numerically controlled machines, which form the basic module necessary to achieve total flexible manufacturing.

Their blue collar workers are graduates, typically, of technical high schools or senior high schools. And we are told the curricula of those institutions is equivalent to about a 2-year junior college degree in the United States.

After employees are hired by a company, they then are given extensive training, both on the job and off the job by their companies. Educational programs are mapped out for them and in several of the companies we visited, employees regularly meet with education supervisors who chart their progress and recommend changes in their curricula.

In two of the machine tool companies we visited, after a blue collar worker is hired, he will spend 1 year attending classes in that company before he ever goes to work on the shop floor.

And this is not considered to be just a one-shot affair. After they then go to work, as I mentioned, there is a continuing education program that lasts throughout the employee's stay with that company.

Now this is combined with extensive job rotation in most facilities, both of blue collar and white collar people, and in many companies it is combined with a pay scale, which is geared to the number of skills, particularly that the blue collar people master.

So if you can operate one type of machine or one class of machine, you receive one level of pay. And if you can operate more, you receive additional bonuses. I believe the maximum is when you can operate five kinds of machines.

The implication of this is that you have people who are capable of operating many machines and therefore capable of participating in multi-machine manning, so one person will be responsible for the operation of several machines operating simultaneously, as opposed to operating just one machine and staying with that machine throughout the entire fabrication process.

Senator BINGAMAN. Did you indicate that job rotation is part of the normal plan of many of the companies you visited?

Dr. KELLY. Yes, sir. It was. Of the companies that we visited, in fact, in one of the companies the current director of marketing, I believe, 3 years earlier had been the chief engineer for this facility and 3 years prior to that had operated the largest manufacturing enterprise associated with this company.

So it not only applies to the blue collar people but also to the white collar people. In fact, the managing director of one corporation said, if you are going to have flexible manufacturing, you have got to have flexible people.

Senator BINGAMAN. Okay.

Dr. KELLY. The long-term effect for Japanese industry of this tremendous emphasis on education is increased creativity that has accelerated the pace of new manufacturing technologies in the workplace.

Finally, the last factor, and certainly not an emphasis, is the pervasive attitude about quality that permeates all segments of Japanese society. And I mean that quite literally.

It not only permeates manufacturing, but it is talked about by the people who are the starters for the elevators in the hotel, the cab drivers, everyone. Japanese have embraced total quality control, they call it total quality concepts.

In business, you find people in research, sales, planning, training, design, subcontractors, the vendors, production, field service, everyone talks about quality, and attends courses on how to improve quality.

It is considered simply to be everyone's job. And one person observed that what this does is return the craft to manufacturing by making each person responsible for process control inspection and for initial fixes of problems in his particular area.

The Japanese believe quality is designed in, not inspected in. They design the manufacturing process to exhibit as little variabili-

ty as possible, and then in those areas where it is not economical to design our variabilities that could affect quality, they design the product to be robust in the face of that variability.

In contrast all too often in the United States, quality is perceived as being the responsibility of a designated group, usually called quality assurance department. And there is no real emphasis to incorporate a total quality concept that can be ingrained into each employee's attitude toward work.

There tends to be, all too often, an emphasis on inspecting in quality and inspecting it in so-called at the tailgate, when the product is completely assembled, rather than conducting inspections at every stage in the process and having the employees themselves do that.

In conclusion, there is a clear link between manufacturing and national security. Advanced weapons require complex manufacturing processes and advanced production equipment, which in turn requires broad-based domestic manufacturing capacity.

In the future, if the United States is to be competitive in world markets, both defense and civil sector manufacturing will require much greater manufacturing flexibility than is currently exhibited.

While Japan is most frequently identified as a primary international competitor, manufactured know-how has now spread to many countries.

Manufacturing effectiveness—the rapid development of new, high quality products at the right time and at the right price—is a principal determiner of Japan's international competitiveness.

It is driven by a strong motivation to export, stemming from the fact that Japan is a raw material poor, mercantile economy, and by a focus on market share leading to long-term investment in research and development to improve products and to develop improved manufacturing means. Manufacturing means are continually upgraded through access to low-cost capital.

The Japanese have a variety of institutional and organizational means to shorten the time required to commercialize new technologies. MITI functions to set long-term strategies and underwrite high-risk ventures.

They practice innovative design approaches, and aggressively use concurrency in product development. They emphatically believe that their manufacturing excellence derives from their emphasis on quality, beginning with product and process design.

They believe you design quality in, not inspect it in. That concludes my testimony, Senator.

[The prepared statement of Dr. Clinton Kelly follows:]

STATEMENT BY
DR. CLINTON W. KELLY, III
SPECIAL ASSISTANT TO THE DIRECTOR
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

1.0 Introduction

The objective of the DoD Technology Assessment Team was to assess US and Japanese manufacturing technology in light of national security and international economic strength. The DoD recognizes that the security of the United States rests on both technologically superior weapons sytems and a strong industrial base to produce them.

A 1983 bi-lateral agreement between Japan and the United States provided the opportunity for the Department of Defense to study Japanese manufacturing first hand and to begin identifying what it is about Japanese companies, manufacturing practices and industry/government relationships that accounts for the remarkable performance of Japanese manufacturing. A sample of the performance indicators is reflected in Table 1. In response to these agreements, the Technology Assessment Team (TAT) for Manufacturing Technology was formed in the summer of 1986 at the request of the Deputy Under Secretary of Defense (Research and Advanced Technology) and the Deputy Under Secretary of Defense (International Programs and Technology), and made its first survey trip to Japan in January 1987. An additional trip is planned for the fall of this year. At that time I hope that it will be possible for part of the team to visit selected industries in Korea and some of our NATO allies.

To prepare for our trip to Japan, TAT members visited a series of US Defense contractors. While in Japan, the TAT visited eleven companies representing the full range of industries. From my observations during the TAT visits, I perceive that there are basically three important factors: (1) The Japanese are able to rapidly transition advanced manufacturing technology into the production environment; (2) Japanese companies are, by nature, highly efficient just to survive a brutal domestic competitive environment; and (3) Obsession with product quality is the cornerstone for long-term market share and economic growth. There are other cultural, geographic, historical and economic factors which influence Japan's current economic strength. They can all be summarized by the statement, "Japan's competitors are being outhustled."

Why are the Japanese so successful?

2.0 Japanese Manufacturing

There is no single adequate explanation for Japanese manufacturing effectiveness. Rather, manufacturing performance is a function of many interacting variables. For ease of discussion, I have grouped them into four categories:

1) Rapid Commercialization
2) Nature of the Manufacturing Enterprise
3) Human Resources, and
4) Quality.

2.1 Rapid Commercialization

Competitive pressure is such that Japanese manufacturers go to extraordinary lengths to accelerate the introduction of a new product. This is fostered at the national level by the Japanese Ministry of International Trade and Industry (MITI), a body for which we have no analogue in the US. MITI assists Japanese companies to attain capabilities that they could not afford by themselves by providing incentives for long term research, low cost financing for plant upgrades, and underwriting national initiatives in leading edge technology programs.

The Japanese typically employ a sophisticated design approach which accelerates product development. It is variously called design for automated assembly, design for manufacturability, or concurrent design. This design approach results in products with reduced part counts which are readily fabricated and assembled by automated machines. The product and components are then rapidly manufactured using the simplest possible processes. By minimizing component count and optimizing the production process, direct and indirect costs are reduced and product quality is enhanced.

During the product development phase, many Japanese companies give broad responsibilities to a small product development team, allowing them to practice concurrent design. This team must represent the marketing, conceptual design, product engineering, manufacturing, and field support functions. This is done to assure that the product is designed as rapidly as possible and that the design satisfies the requirements of all the functional departments. The product development team thus typically overlaps several phases of development with no clear boundaries between them. This approach

contrasts with the sequential process used by many US companies and required in most DoD programs. The tradeoff here is between design maturity and early market introduction.

2.2 Nature of the Manufacturing Enterprise

The Japanese view manufacturing as a strategic factor which contributes as much to the national competitive advantage as product design or marketing. Given this attitude, it is not surprising that in Japan approximately 40% of a companies' research and development budget may be spent on manufacturing R&D, while in the United States typically less than 10% of a companies' R&D budget would be spent on manufacturing technology.

Another characterization of Japanese manufacturing is seen from a material flow perspective. Japanese factories are designed to work on a "flow-thru" or stockless production basis with each stage in manufacturing producing only the amount of material required for the next manufacturing step. In most US factories, materials come in from suppliers, go into storage, and are issued in quantity for a manufacturing operation which produces multiple units for the next stage. The work-in-process is returned to storage and then eventually proceeds to the next stage in the process. The Japanese approach attempts to keep the material moving from one processing step to the next without the intervening return to storage. This approach has several major benefits. First, each person in the process knows that his customer is the next person down the line. This realization, combined with the knowledge that there is no buffer stock, causes each person to make certain that he produces a defect-free unit -- otherwise the line stops. Thus, an organizational or factory design concept has a major effect on quality. Second, control over the manufacturing process is simplified. The most straight forward way to handle planning and scheduling problems is to reduce complicated material flow. Nowhere in Japan did we find the complicated production control processes, with their associated overhead costs, that are typical in US factories; the Japanese just don't require them.

Another vantage point from which to view the manufacturing enterprise is in terms of the automation on the shop floor. The TAT found about as much in automation as we expected (approximately 40,000 installed robots vs. 10,000 in US), but what we

found generally wasn't as sophisticated as we expected. The Japanese view automation as a means to improve quality, increase production, and gain market share, not as a means to reduce direct labor. They retain workers for very complex tasks for which robotic devices are either too costly or beyond their technical capability and for those tasks that will change substantially as the product changes. They explicitly design their products so that fabrication and assembly tasks can be handled by simpler devices with perhaps no more than four degrees of freedom. This reflects the concurrent design philosophy discussed earlier. In the US, we would probably accept the design as given and develop a complicated device to assemble it. In Japan, the designer works with the characteristics of the available devices in mind. The simpler robots are less costly, easy to program and easy to maintain. Japanese factories reflect the judicious integration of people and machines, balancing cost, flexibility, and quality of products produced by machines against the cost, flexibility, and quality of products produced by people, reserving the simpler tasks for the machines and the more complex tasks, which are more difficult to automate, for people. Automation is introduced slowly after much study and "rationalization," and its introduction is facilitated by the flow-through philosophy which highlights problem areas where automation might be used to best effect.

In the US, an automation system is regarded as a purchased project with a "beginning, a middle, and an end." Its development is left primarily to equipment suppliers and the crucial link between product and process design is lost. In addition, it is presented "as is" to workers who can't incrementally improve it because they don't understand it. In Japan, automation is developed from within; there is heavy worker involvement, and the entire venture is focused on incremental improvement.

Viewed from any perspective, the Japanese manufacturing enterprise is impressive. It is all the more impressive when you note that much of what has been achieved does not involve central computer control or CIM (Computer Integrated Manufacturing). That becomes more significant when you realize what the addition of CIM and central computer control linking all production equipment could mean. The Japanese are beautifully positioned to make such a move. That could put them in a world leadership position for economical, small batch, mixed mode manufacturing.

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2.3 Human Resources

Some key human factor characteristics surfaced as pillars of the Japanese industrial community during various plant visits. These characteristics include the prestige associated with manufacturing, a significant commitment to company sponsored education and training, and company philosophy. Because of the internationally recognized success of Japanese manufactured products, individuals in the manufacturing community have been recognized as highly regarded members of society. As a consequence, the manufacturing community tends to attract a larger share of the "Best and Brightest" college graduates. The long term effect for Japanese industry is increased aggressiveness and creativity that in turn has accelerated the pace of new manufacturing technology applications and related programs for continuous improvement of existing resources.

In the area of company sponsored education and training, a comprehensive approach had been established within each company visited. Each company training program included training for all levels of management, production, employees and instructors. Dimensions of the education and training initiatives included on-the-job training (OJT), individual learning, correspondence courses, company support for obtaining professional licenses and an assistance program for self development. In the area of off-the-job training (Off JT), participation in professional societies, leadership role development, quality circles, correspondence courses, and development of individual potential were all actively encouraged and supported by Japanese companies.

2.4 Quality Assurance

The emphasis on "Total Quality Concepts" (TQC) was observed as a predominate factor in all areas of business operations -- R&D, Sales, Planning, Training, Design, Subcontractors, Production and Deployment. TQC is a major determiner of market share and identified as a key element for market strategy. The concept of TQC emphasizes a continuous process of improving quality level achievements. The continual improvement of quality leads to reduced cost because of less rework, fewer mistakes, fewer delays, fewer snags and better use of machine time and materials. This improves productivity, while at the same time allowing the product to capture a larger share of the market and providing for more jobs. Because of the successes achieved through TQC, a

national obsession for quality seems to be well entrenched throughout the Japanese industrial base. In contrast, the US industrial base perceives quality to be the total responsibility of a designated group, usually referred to as the "Quality Assurance Department." Quality levels are established to meet government standards and there is no emphasis to continually improve quality levels or to incorporate a total quality concept that can be ingrained in each employees attitude.

The educational and training programs reflected a great deal of management attention and influence. Individual goals were set up for each employee to progress through a series of self improvement programs and individual initiative as well as the significance of team activities work to make the company successful.

Observations associated with company policy reflected that most companies visited incorporated programs for life time employment, a comprehensive total quality approach, job rotation at all levels, and the importance of the company as an extended family environment.

3.0 Conclusions

There is a clear link between manufacturing and national security. Advanced weapons require complex manufacturing processes and advanced production equipment which in turn requires broad-based domestic manufacturing capacity. A weak industrial manufacturing base implies that the United States would have insufficient production capacity to meet the requirements of a conventional war of attrition and that the ability of defense contractors to maintain broad technical superiority would be severely limited. Production capacity and the technological level of defense systems are coupled. In the face of a declining industrial manufacturing base, defense systems would become more expensive and would lack the technical sophistication required to combat quantitative deficiencies.

In the future, if we are to compete, both defense and civil sector manufacturing will require greater manufacturing flexibility than is currently exhibited. Defense manufacturing will have to be explicitly geared to respond rapidly to changing enemy initiatives and to take timely advantage of technological opportunities so these can be translated into operational gains. The civil sector will have to be geared to take

advantage of rapidly changing "niche" markets which provide transitory opportunity for sales.

While Japan is most frequently identified as a primary international competitor, manufacturing know-how has spread to many countries. The impact will increasingly be on defense, as well as the civil sector. It may be reflected in growing foreign sourcing of components for our defense systems and changing balances in international sales of defense equipment.

Manufacturing effectiveness (the rapid development of new high quality products at the right time and the right price) is a principal determiner of Japan's international competiveness. It is driven by a strong motivation to export stemming from the fact that Japan is a raw material poor, mercantile economy, and by a focus on market share leading to long term investment in R&D to improve products and to develop improved manufacturing means. Manufacturing means are continually upgraded through access to low cost capital.

The Japanese have a variety of institutional and organizational means to shorten the time required to commercialize new technologies. MITI functions to assist companies where they cannot assist themselves. They practice innovative design approaches and aggressively use concurrency in product development. They sincerely believe that their manufacturing excellence derives from quality.

Manufacturing Enterprise Comparisons	Japan	vs U.S.
1. Indirect to Direct Labor Ref: 1) Harvard Business Review, "Simple Truths of Japanese Mfg" 2) TAT Notes, Jan, '87	4:1	8:1
2. Non Conformance/Rework (Electronics) Ref: TAT Notes, Jan, '87	1/2-1%	8-10%
3. Working Stock/Inventory on Hand Ref: 1) TAT Notes, Jan. '87 2) "Working Smarter," W. S. Rukeyser	Up to 2 mos.	Up to 9 mos.
4. Number of Robots Employed for Welding, Assy, Mat'l Handling Ref: 1) Dayton Daily News-API (DDN-API), 5/6/87 2) TAT Notes, Jan. '87	40,000 +	10,000+
5. Product Span Time-Order to Ship (Machine Tools) Ref: TAT Notes, Jan. '87	1-2 mos.	5-6 mos.
6. Personnel Turn Over - % of Enterprise Population Ref: TAT Notes, Jan.'87	1%	10-12%
7. Average Work Hours Per Employee Per Year Ref: DDN-API, 5/6/87 TAT Notes, Jan. '87	2152	1898
8. Average Age of Plant Equipment-Total Ind. Base Ref: William S. Rukeyser, "Working Smarter"	10 Yrs	17 Yrs
9. Private Investment in Plant Eqpt.as Share of GPN Ref: William S. Rukeyser, "Working Smarter"	17%	10.2%
10. Average Manufacturing Labor Wage (87) @ $1=150 yen Ref: DDN-API, 5/6/87	15.20	9.17
11. Electronic Sales to Opposite Country (86) Ref: DDN-API, 5/6/87	$23.9B	$3.5B
12. Number of Manufacturing Jobs (86) Ref: "The Economist," Aug. '86 Survey	15M	20M

TABLE 1

Senator BINGAMAN. Thank you very much. Let me just ask you a few questions before we call our industry panel to come up and join you.

How extensive was your assessment? How much time were you able to spend in Japan? And how many facilities were you able to visit?

Dr. KELLY. I made three trips personally. The last trip in which I was accompanied by all members of the team was in January of this year, and we were there for almost 3 weeks.

Let me just read a list of the companies that we visited, if that would be appropriate.

Senator BINGAMAN. Okay. That is fine.

Dr. KELLY. In the area of electronics, we visited NEC, Nippon Electric Co., Oki Electric, Toshiba and Sony. In the area of aerospace, we visited Mitsubishi Heavy Industries and Kawasaki Heavy Industries.

In the area of machine tools, we visited the Toyota Machine Works, the Yamazaki Mazak Machine Tool Co., and the Fana Machine Tool Co. In the area of steel and basic metals, we visited Sumitomo Heavy Metals.

And then in electronics and manufacturing research, we visited Hitachi. And we plan a follow-up trip this October and will probably visit an additional five or six companies that we were unable to schedule on the earlier trip.

Senator BINGAMAN. Was part of your assessment U.S. technological practices and capability?

Dr. KELLY. What I did personally, since up until a year or so ago, I knew absolutely nothing about manufacturing, was to visit a number of U.S. facilities to establish a baseline against which I could compare practices that we observed in Japan.

Dr. Parrish, Dr. Russo, and Mr. Tupper already knew substantially more about that than I did, because of the research programs they have been pursuing.

Senator BINGAMAN. But the idea of establishing the baseline was to be in a position to make some comparisons between the U.S. manufacturing practices and state-of-the-art?

Dr. KELLY. Yes it was.

Senator BINGAMAN. Let me ask you along some of these lines about comparisons. You indicate on the nature of manufacturing that one thing that struck you was the priority given to manufacturing technology research by the firms that you visited. What is your understanding or your assessment of the extent to which some of our firms have concentrated on manufacturing technology research?

Dr. KELLY. In my personal opinion, Senator, there has, in general, historically, beginning say with the 1960s, been substantially less emphasis on manufacturing technology in the United States than there has been in Japan.

However, every place I visited, I received the impression that there is increased awareness of the importance of manufacturing technology research and increased activity in that area.

Senator BINGAMAN. You say, starting in 1960. What happened in 1960 to cause us to deemphasize this?

Dr. KELLY. I would be happy to give you a speculation. Again, just my personal opinion.

Senator BINGAMAN. Sure.

Dr. KELLY. But based on what I have read and the people with whom I have spoken, it appears that beginning about the 1960s there developed a set of attitudes, perhaps based on the fact that the United States had dominated its own domestic markets and to a great extent dominated many international markets since the end of World War II, that we really knew as much as we needed to know about manufacturing technology development.

I guess I would say it was an attitude of complacency. There seemed to be more interest in product development, and marketing, and less interest in manufacturing.

Now, it has been argued in a number of the books which have been written on the topic, that this was accompanied by a decline in the number of people in senior management positions in corporations who had experience with manufacturing.

Over a period of time, managements of corporations began to reflect people who had more of a financial or management background, and less of a manufacturing background, and that also could be responsible for a deemphasis in manufacturing as an area of strategic focus for a corporation.

As I say, that is a personal opinion, a speculation, and I have to qualify it by saying that up until a year ago I knew virtually nothing about manufacturing.

Senator BINGAMAN. Let me ask on another characteristic you cited of Japanese manufacturing operations. You indicated that they were stockless, that they worked toward very low inventory or no inventory being the goal.

Dr. KELLY. Yes.

Senator BINGAMAN. How does that compare with the U.S. firms that you and the team are familiar with? Is it common for us to have a very substantial inventory and stock situation in our manufacturing operations?

Dr. KELLY. That was true everywhere we went in the United States. That is, we had large inventories.

In Japan, I believe the largest inventory we saw was about a 30-day to 2-month inventory at Sumitomo Heavy Metals, and that inventory was in very low value raw materials.

In the electronic companies, typical inventory was on the order of 2 to 3 days. Now, I have to add that this is facilitated in Japan by virtue of the fact that the suppliers are all in close geographic proximity to the major companies.

In most companies, the suppliers might be no farther than 50 or 100 kilometers away from the central facility, if they are that far away. But it is an avowed goal of Japanese manufacturing to keep the inventory as low as possible, to simplify the material flow and they have achieved that, I think, very dramatically.

Senator BINGAMAN. On the use of robots, you indicated they are fairly prevalent, and I think you said two thirds of the robots that are used at the present are in medium to small sized operations.

Dr. KELLY. About two thirds of the computer numerically controlled machine tools. As I mentioned, something on the order of 96 percent of all Japanese manufacturing enterprises employ less

than 300 people. And in fact a large number of them may have fewer than 20 employees.

And this evokes images of some sort of an operation using outmoded machine tools and perhaps dirt floors. We understand the reality, in fact, is quite different from that, these small shops which may have on the order of 6 to 20 people may very likely have the most modern computer numerically controlled machine tools that the market can provide.

I might add that we were unable to visit any of the second and third-tier companies. We hope to rectify that on our next trip.

Senator BINGAMAN. Do you have a sense for the relative use of these computer-operated machine tools, robots, in U.S. firms' manufacturing operations?

Dr. KELLY. They certainly were in evidence in every facility we visited. My belief is, there are substantially more of them installed within Japanese industry than within U.S. industry. But, that is just a matter of speculation on my part.

Senator BINGAMAN. I have read several articles where the computer integrated manufacturing has been held out as the great hope for dealing with the problems we face in manufacturing.

To the extent you can, give us your personal opinion on the relative capability of U.S. firms to employ computer integrated manufacturing techniques, as compared to the Japanese.

You indicated that the Japanese, if they were to move forward aggressively with computer integrated manufacturing, would have a substantial lead. To what extent are we positioned to move forward with computer integrated manufacturing?

Dr. KELLY. In my personal opinion, the biggest barrier in incorporating computer integrated manufacturing is not technological, but it is an issue of education.

Education on the part of management as to how to use the potential that technology offers, and education on the part of the workers in how to actually operate the machines that might be involved in such a facility.

I believe because of the evolutionary approach the Japanese have taken in arriving at a point which poises them to take advantage of this technology, without for the moment commenting on whether or not they have the technology to take advantage of, they have substantially preceded us in this education process.

They have thought for a long period of time about what it takes to make a very efficient manufacturing operation. They have relentlessly rationalized, or justified, every single thing in their manufacturing operation.

They understand very clearly what the potential bottlenecks are and how automation, in one form or another, can help them. As a consequence, they have these very smooth-running facilities which are better able to take advantage of the technologies that make up computer integrated manufacturing than many U.S. industries might be.

Senator BINGAMAN. So your personal view would be that they are in a much better position to move forward in this area than we are?

Dr. KELLY. That is my personal view. I might add, I also believe that we are in possession of the technology to implement computer

integrated manufacturing, and it is not at all clear to me that they are.

Senator BINGAMAN. So we are in possession of the technology, but they are not. Our practices and our training and retraining practices do not lend themselves to application of the technology. Is that what I understand?

Dr. KELLY. That is my opinion.

Senator BINGAMAN. Whereas their practices do. So once they get the technology, they are likely to be able to actually use it.

Dr. KELLY. That is my opinion, Senator. We found in every Japanese corporation that we visited, a number of expressions of intent in this area.

I might add, we also found that a couple of the corporations, since when we visited the yen was going through rather dramatic revaluation, had an intent to do it because they wanted to make a profit at 120 yen to the dollar.

Senator BINGAMAN. We are moving toward that. Let me just ask one final question then I will defer to Senator Dixon and Senator Warner to ask questions.

DARPA's involvement in assessing the manufacturing technology situation in this country and in Japan, I think, is interesting. Perhaps you could briefly describe what you see as the proper role for DARPA in this kind of activity. This is not something that you have traditionally been involved in. The Armed Services Committee agreed to a significant increase in funding for DARPA, at least in the authorization bill, if that becomes law, which would involve DARPA actively in this kind of assessment and research.

Maybe you could give us your thoughts as to where DARPA could make a contribution in this area.

Dr. KELLY. I would not propose to speak for the Director of DARPA, Senator. So I will just express my opinion. DARPA could pursue a number of manufacturing technology research projects consistent with its mission which could lead to improved weapons systems.

For example, DARPA could explicitly consider the manufacturing aspect of all our major system technology programs. This might be done early in a program by conducting studies to determine what future manufacturability issues would be cost drivers in the system developments that we are carrying out.

We could then identify the specific manufacturing technology base effort required to ensure that the technology is producible at the system level. In this scenario, each advanced technology systems effort would be accompanied in parallel by a companion advanced manufacturing technology effort.

And this might do much to facilitate the rapid transfer of DARPA research to service programs, and to shorten the time to deliver a technological edge to the operating forces. Let me, if I may, just enumerate some of the programs that could be the focus of such efforts.

Fabrication of ceramic armor, the manufacture of structural elements from high temperature metal matrix composites for the national aerospace plane, manufacture of electromagnetic devices from new superconductor materials, fabrication of low-cost ceramic hydraphones for an antisubmarine warfare system, development of

low-capital cost silicon and gallium arsenide wafer fabrication technology, the intent of this being to reduce the capital cost of facilities to produce wafers both out of silicon and out of gallium arsenide.

Manufacturing ceramic micro-structures for an advanced fuel cell, and development of numerical simulation capabilities using advanced parallel machine architectures developed out of the strategic computing program.

This capability could be used for such applications as a Mach 25 numerical wind tunnel, simulation of advanced new materials, and the simulation of advanced materials processing technologies.

It may be the case that a number of these technology efforts would be held in common, and in such a case it might be appropriate to approach them through the use of a micro-factory concept. And this concept could serve to address many of the competitiveness issues that I previously discussed.

The objective of this micro-factory concept would be to provide a working laboratory to improve both the product and the production process.

A typical micro-factory would, as the name implies, be relatively small, it would be highly automated, and would be highly flexible, able to produce small batches of certain classes of products. Thus the focus would be on flexible manufacturing for low-volume production.

Micro-factories could serve to bring together experts in the universities and industry to jointly advance the state of manufacturing technology in many areas. In this regard, they could function similarly to a teaching hospital, providing a small permanent nucleus of staff to carry out research and conduct on-site training both of graduate students, and of manufacturing fellows drawn from industry.

The technologies contained in the micro-factories, and the practices developed there, could provide the basis for curriculum development in manufacturing technologies. Such an environment could be very exciting, and could serve as a vehicle to attract the best and the brightest students to the manufacturing-engineering career field, and contribute to the establishment of a broad base of manufacturing expertise and capability for both defense and commercial applications.

Again, I am not speaking for the director. These are just my personal opinions of things that I believe DARPA could do consistent with the commission.

Senator BINGAMAN. You made some very interesting suggestions. I will defer to my colleague, Senator Dixon, for him to make any statement he wants or ask any questions.

Senator DIXON. Thank you, Mr. Chairman. Dr. Kelly, in talking about advanced manufacturing technology and things of that character, is all the research and development done in the private sector by private investment process, or is the government involved significantly?

Dr. KELLY. Senator, in my opinion there is government involvement. But more and more of it is being done in the private sector.

MITI, for example, I understand from discussions we had in Japan, arranged for Japanese companies to acquire robotic technol-

ogy very rapidly through the use of various mechanisms which made it more economically feasible for those companies to acquire the technology.

I understand that these included some tax writeoffs, and in many cases outright loans or grants to companies to help them quickly acquire the technology.

They have a facility at Skuba, north of Tokyo, in which there is a large laboratory focusing on very advanced manufacturing technologies. We hope to visit there. We were not able to on our most recent trip.

On the other hand, MITI, set out with the goal in mind of creating diverse competitive Japanese industrial sectors. They have now done that. And you begin to see more and more of the research being carried out in the large corporations, and an expressed intent on the part of many of the senior managers of those corporations to go it alone without MITI assistance.

Senator DIXON. But I take it that your observation is that either through tax writeoffs, which is a significant benefit generally eliminated by our last tax reform legislation, or by loans, I presume at moderate interest rates, or even outright grants, their industrial capabilities are enhanced by government support.

Is that a fair statement? And does that distinguish them from American industries who would like to be competitive with them?

Dr. KELLY. Senator, I am afraid you have really exhausted my knowledge of the subject.

Senator DIXON. Well, I do not expect this to be really a full development of the thesis actually. I just wanted a kind of simplistic understanding of whether there are significant differences in that area.

Dr. KELLY. As far as I can determine, again my personal opinion, MITI is quite unique. I have not seen anything like it in terms of the breadth of functions that it can carry out within the United States.

Senator DIXON. You see, some of us on this committee are vitally interested in the question of our deteriorating defense industrial base.

I have been working on it for months and I am prepared in the next several days to introduce some legislation on the basis of the expertise that has been made available to me. But I am still very cautious about how we proceed. That is why I wanted to develop this with you.

For instance, I think your conclusion is absolutely correct. There is a clear link between manufacturing and national security. Advanced weapons require complex manufacturing processes and advanced production equipment, which in turn requires broad-based domestic manufacturing capacity.

A weak industrial manufacturing base implies that the United States will have insufficient production capacity to meet the requirements of a conventional war of attrition and so forth.

I think my colleague and friends, the chairman, and others who serve on the Armed Services Committee with me, share that concern expressed in your conclusion. That is why I was trying to walk through some of the distinctions that some of us wonder about with

respect to obviously Japan. I'm not picking on Japan, I'm publicly complimenting Japan by saying this, you understand.

And I wonder whether that is significant. Some would suggest that there is a difference in the wages we pay. Is that very significant now?

Dr. KELLY. My opinion, Senator, particularly with the revaluation of the yen, is that in Japanese manufacturing today, the average wage paid, denominated in U.S. dollars, is actually greater than in U.S. companies.

Senator DIXON. Well, we have been told that lately, and I wondered whether that was as factual as you seem to suggest that it is.

Dr. KELLY. I can give you some anecdotal evidence which suggests that it might be more likely true, and that reflects the higher percentage of engineers in Japanese manufacturing enterprises.

Presumably the engineers would be paid more, and that in part could account for the——

Senator DIXON. Could you make available to me, through my staff, Charles Smith, whatever you have along those lines?

If you have comparative wage rates for countries other than just Japan like West Germany, France, or other competitive nations, I would be interested in that information as well.

[The information follows:]

Representative, average manufacturing wages (excluding overtime), at two Japanese companies:

1. Large automobile manufacturer.
Y5.9M/yr. total salary.
Y3.245/yr.—Base pay.
Y1.95/yr.—Bonus.
Y.71/yr.—Fringes.
Equivalent to $45k/yr. @ Y130/$ or about $22/hr.

2. Large aerospace company.
Y6.4M/yr. total salary.
Y3.8M/yr.—Base pay.
Y1.3M/yr.—Bonus.
Y0.720M/yr.—Fringes.
Y0.6M/yr.—Retirement.
Equivalent to $49k/yr. @ Y130/$ or about $24/hr.

Senator DIXON. Now, let me ask you a kind of simplistic question that we wonder about when we discuss the question of the defense industrial base.

If we accept the conclusion that you give, which I do accept as solid and well-reasoned, then we extrapolate from that what we ought to do and try to define what the process ought to be in government to address this problem.

How do you, on a selective basis, find exactly what the manufacturing capability is that you ought to have for national security purposes? Can that be defined in a reasonable way?

Dr. KELLY. In my opinion, it certainly is within the realm of possibility. I believe it is a very complex issue that would require substantial analysis.

I think it is the sort of thing we just do not give opinions about offhand. My belief is that it would require a substantial amount of study and thought.

Senator DIXON. I think that is true. But maybe it is doable. Let us say that it is possible to identify the types of manufacturing capability you have to have in the event of a tremendous national

emergency to meet national security needs. Let us argue that that could be done. I guess the next step beyond that would be for the short-term. From the standpoint of the public reaction in a country that is an open democracy, where everybody expresses their points of view, what do you do about those who would say, hey, somebody else can make it cheaper, maybe even better, and we are not performing a service for our domestic constituency here when we do this.

How do you address that?

Dr. KELLY. I think it involves some very profound policy decisions, and I must confess candidly that all of the issues that might enter into such decisions just fall outside of my area of competency.

I wish that were not the case. But I am afraid it is. I am new to this area. I am basically a technologist. And although I find these issues fascinating, I am just not sufficiently familiar with them to give you a well-reasoned opinion.

Senator DIXON. On the basis of what you have done and seen in your research, is there even a slight probability that we could eventually develop the capability to be truly competitive in our manufacturing capability in those areas where there is a distinct national security need?

Dr. KELLY. The remarkable observation, I guess, about Japan is that we saw no manufacturing technologies at the process level which we thought were particularly innovative or terribly unique.

That is not to say they do not exist. But it does say that we did not see them or perhaps we were exposed to them and just did not know what we were seeing. But I tend to think that there are not that many of them.

What we saw was a remarkably well thought out manufacturing enterprise, where every element in it had been subjected to this relentless process of rationalization and justification.

Senator DIXON. But some would suggest that government is almost a partner in industry in Japan and that this is a process that is evolutionary. They really think ahead and have long-term plans, government cooperating with industry to achieve the kinds of results they do in a distinctly different pattern than we do under our free enterprise theory in this country.

Is that true? Is that really the case?

Dr. KELLY. The only government involvement, Senator, that we were personally told about, and that came up in discussions at the companies we visited, was the MITI involvement. I had heard observations similar to those you made. I am just simply not qualified to comment on their validity.

I might add, though, if I could just wrap up your earlier question, in the United States, we visited a number of facilities and we saw a process technology which I thought was really very unique, very innovative.

So, on the one hand, in the United States, we have elegant technology that could be brought to bear on the manufacturing enterprise. In Japan, we did not see the elegant technology, again, not to say it does not exist, but it just says we did not particularly see it.

But we see the beautifully orchestrated manufacturing enterprises. My belief is that we have the technology to be extraordinar-

ily competitive, to be the world's greatest manufacturing nation, should we choose to do so.

Senator DIXON. Is this a uniquely distinct type of problem we are experiencing now? When we talk about a deteriorating industrial base that concerns us from the standpoint of our national security interest and things of that character, is that uniquely different than at any other time in our historical experience; in modern times, for instance, as compared to the World War II or other times? Or are we actually a nation that just kind of ho, ho, hos along until there is a problem, and then says, hey, we have got to get everything together? Do you understand what I am asking you in that regard?

Dr. KELLY. Yes, I——

Senator DIXON. Is this a different experience now than it was in the late 1930s and early 1940s as an example?

Dr. KELLY. I am not a historian, although I sometimes wish I had spent more time studying history, particularly industrial history.

In my personal opinion, the changes that we see around us now, looking over the last 20 or 30 years, are in fact somewhat different, because they are driven by a growth of a series of technologies that I think is unprecedented in history.

And the growth of these technologies and the character of these technologies makes them available to lots and lots of countries. So that the kinds of competition that we are facing and will increasingly face in the future, I think, will be qualitatively different from what we have faced in the past.

Senator DIXON. Okay. That being the case, that there is a difference, a problem now that we ought to see, having in mind your conclusion for those of us who agree with it, would it be your challenge that we definitely should do something about this? There may be questions about the guidelines that we ought to be addressing in a very serious way what I perceive you to think is a major type of threat to our national security interest.

Is that a fair conclusion?

Dr. KELLY. In my personal opinion, we need to take advantage of the technologies that are available to us to redress these trends which I believe are quite serious.

Senator DIXON. I thank you, Dr. Kelly.

Senator BINGAMAN. If you have additional questions, go ahead.

Senator DIXON. Mr. Chairman, I have to leave to go to another committee right now. I am on the Banking Committee. We have Mr. Volcker for his good-bye.

Senator BINGAHAM. All right. Give him my best.

Senator DIXON. Thank you, Dr. Kelly.

Dr. KELLY. Thank you.

Senator BINGAMAN. Let me just ask two more questions. This is somewhat redundant, but I think I would just like to be real clear on it.

I gather what I hear from you is that the challenge we have is to apply the technologies we have already developed and that you do not see a great need for development of new advanced manufacturing technologies in some kind of basic research sense.

You see a substantial gap between what we now have developed and what we are applying. Is that accurate?

Dr. KELLY. It is certainly accurate in my opinion that a great deal of progress could be made by applying technologies which are available today.

It is also my belief that we must pursue vigorous research in the area of advanced manufacturing technologies because we must not stop just by redressing potential imbalances, but must try and leapfrog ahead of the competition.

And I believe one can do that only by having a substantial research program in manufacturing technology, and substantial initiatives in education, developing the people who can learn to design and operate these potential new manufacturing enterprises based on these new technologies.

Senator BINGAMAN. All right. Senator Chris Dodd, who is not a member of the Armed Services Committee, but who is very interested in these issues, has asked that I mention his inability to be here today.

Mr. Bennett, who is the President of Torrington Co., is here representing the ball bearing industry, and Senator Dodd wanted to be particularly mentioned as welcoming you as a witness here.

Mr. BENNETT. Thank you, Senator.

Senator BINGAMAN. Let me just introduce the panel very briefly here.

The panel includes Mr. Charles Gilbert, President of the Cincinnati Gilbert Machine Tool Co., and Chairman of the Board of Directors of the National Machine Tool Builders Association.

Mr. Thomas Bennett, Chairman of the Anti-Friction Bearing Manufacturing Association and President of the Torrington Co., which is a manufacturer of ball bearings.

And Dr. Bob Leshne, who is President of Trans World Optics, a manufacturer of precision optical devices. Dr. Leshne is also President of the American Precision Optics Manufacturers Association.

I think this group is ideally chosen to give us a view from the trenches. We have, of course, talked to some of the representatives of the large prime defense contractors, and today we want to get testimony from you gentlemen.

Why do we not start.

Dr. Leshne, why do you not go right ahead. We are glad to have you here, and we look forward to your testimony.

STATEMENT OF DR. ROBERT LESHNE, PRESIDENT, TRANS WORLD OPTICS, INC., HAUPPAUGE, NY

Dr. LESHNE. Thank you, Senator. The American precision optics manufacturing base has for the past several years been severely impacted by Asian and foreign interests which targeted the industry and caused serious inroads on its ability to function as a strong and viable source of supply to the DOD.

In fact, the results of a DOD survey of the American precision optics industry concluded that imports of optical components have caused a significant decline of the domestic optics precision capability, and that further erosion would jeopardize the preparedness posture of the Department of Defense.

Companies in Japan, South Korea, Taiwan and Singapore so greatly undercut our American manufacturers that they now

supply more than 75 percent of the optics used by the Department of Defense.

We have witnessed the loss of the commercial optics base to the point where we no longer produce in noticeable quantities optics for 35mm cameras, studio TV cameras, video cameras, movie cameras, microscope objectives, binoculars, and the list goes on and on.

We have seen our colleagues in the precision optics base forced to cut back expansion programs and R&D projects, lay off workers and face bankruptcies. We are now facing a potentially critical shortage of skilled optical workers, and if we cannot increase our diminishing supply of master opticians by implementing our planned training programs, we shall have a situation impossible to rectify.

The Department of Defense is aware of the potential threat to our national security which results when they must rely on foreign sources of supply. The American precision optics manufacturers must strengthen the industry to ensure supplying the DOD with its current and future requirements.

NATURE OF COMPETITION BETWEEN AMERICAN AND FOREIGN COMPANIES

Regarding the nature of the competition between American and foreign companies, when we examine the nature of the competition between American and foreign industry, it becomes evident that several factors exist, which place American industry at a severe disadvantage.

In past years, Japanese labor rates have placed American industry at a labor cost disadvantage. The Japanese system of government-industry partnership formed by the Ministry of International Trade and Industry enables the Japanese to guide the industrial development of its optics industry, to foster the growth of the targeted industry, and to restrict imports to provide further protection.

Japan also provides many benefits to its industries which are not available to the American counterparts. These include tax incentives, extremely favorable interest rates, favored access to loans and foreign exchange, often direct subsidies, anti-trust exemptions, export promotion, and home market protection.

The American precision optics manufacturer is competing not merely with another manufacturer for the market, but with a government-backed competitor.

Government grants and subsidies for research and development are made, as are loan guarantees. The Japanese tax code favors the industry and encourages private research and development.

Primarily, the Japanese were able to underprice optics in the United States because the Japanese Government provided and continues to provide assistance to companies producing products and components of products.

Frequently, only low interest payment has been required by expanding and developing optics firms in Japan, which consequently are not pressed for repayment demands. MITI also enables Japanese optical firms to do many of the things which American indus-

try is not permitted. Collusion and price fixing are against our anti-trust laws. These offenses are tolerated for Japanese firms.

Japanese import barriers are another factor with which American firms must contend. Many requirements are very costly and often delay entry for so long a time that the Japanese manufacturer is finally able to introduce a competitive product.

The Kieretsu are 16 business groups which control a large share of Japan's production and sales. These Kieretsu have an inter-relationship with banks, manufacturers, and trading companies.

Each Kieretsu is composed of a variety of firms in all or most of the major sectors of Japanese economy. These firms are bound together by equity ownership and debtor-creditor relationship ties, and are organized around large commercial banks which use their financial function to coordinate business activities of group members.

Kieretsu members have strong supplier-consumer relations, and purchase only from other members. They control such a large part of the Japanese economy that foreign suppliers cannot compete.

These group agreements hinder American imports, since Kieretsu will purchase only from other member firms, excluding non-Japanese and buying only when business cannot be done with Kieretsu members.

RECOMMENDATIONS FOR ACTION FOR THE DEPARTMENT OF DEFENSE AND CONGRESS TO STRENGTHEN AND SUSTAIN THE PRECISION OPTICS INDUSTRY

1. SUPPORT OF THE FEDERAL ACQUISITION REGULATION

The American precision optics manufacturing base is a group of corporations which supply our Nation with precision optical components critical to our national defense. The members of the industry and the associated and affiliated industries urge the support of the precision optics component clause of the Federal Acquisition Regulation as presented by the Joint Logistics Commanders Ad Hoc Committee.

This states that all precision optical components purchased by the Department of Defense must be domestically manufactured. We urge the support of the FAR because it presents the solution to our industry's problems, and the Department of Defense's concern for a realistic posture of foreign non-dependency.

The FAR will enable the American optics manufacturing base to provide a total source of supply to the DOD for the Nation's peacetime, surge, and mobilization requirements, and will prevent the United States from having to rely on foreign sources of supply for national defense.

2. SUPPORT FOR EDUCATIONAL TRAINING PROGRAM

In the past 6 years, the American precision optics base has lost more than 50 percent of its optical engineers, more than 50 percent of its skilled opticians, and more than 50 percent of it production workers because companies have been forced to close down or lay off workers.

In an effort to avoid a serious potential crisis, the American Precision Optics Manufacturers Association has acted to formulate an

industry-wide apprenticeship training program specifically designed to provide the industry with a future source of trained opticians.

A tentative syllabus was drawn up to include all phases of optical fabrication for a basic 2-year program. This program is not similar to those which have been set up in the past in universities and colleges, remote from industry.

Government support for a national program would ensure its development and provide a positive approach towards solving a potential labor problem.

The situation has become critical and immediate action is necessary, because while there still exists a small cadre of master opticians who are available to train the students, these men are mostly middle-aged or older and contemplating retirement. The program needs to be started at once.

3. FUNDING FOR RESEARCH AND DEVELOPMENT

Congressional and Department of Defense support for a major industry research and development program would enable the American precision optics base to become more competitive on the world market and to strengthen the industry significantly.

A specific research project has been started by members of the American Precision Optics Manufacturers Association when an APOMA committee was formed to develop dedicated automated equipment which the precision optics industry has never before had.

The equipment is specifically designed by precision optics manufacturers, manufacturers of precision optics fabricating machinery, and optical engineers to meet the needs of the precision optics industry.

One result is the prototype of a CNC spherical generator that is now being completed. This product will significantly affect the production of precision optical lenses.

Its use will increase productivity and improve the quality of the manufacturing process to an extent not previously realized by producing lenses which are generated, ground, and ready for polishing in one operation. Only one optician is required for the entire process, when previously two or three would be necessary to produce approximately half the amount of work.

Other projects of this APOMA committee include investigation of sol-gel——

Senator BINGAMAN. Let me just interrupt a moment. What is the name of that machine again that you are——

Dr. LESHNE. It is a generator. A lens generator.

Senator BINGAMAN. A lens generator? Okay. Go right ahead. Sorry to interrupt.

Dr. LESHNE. Sure. Other projects of this APOMA committee include investigation of sol-gel materials for coatings and glass formation, fabrication of infra-red materials with particular emphasis on rapid fabrication and environmental considerations, laser-assisted and ion-assisted fabrication, gradient index optics, subsurface defects, chemically enhanced polishing, and other technology developments of interest to the precision optics manufacturer.

Several of our noted scientists, economists, and historians have concluded that if the current Japanese expansion of industry continues, Japan will become a greater industrial power than the United States within the next 20 years.

And it is also the position of the American Precision Optics Manufacturers Association that American industry, not Japanese corporations, ought to be funding American technology at American universities.

That this is much too frequently not the case is due to the fact that the Japanese have become so successful that their export surplus gives them huge amounts of capital which allows them to step in wherever they have forced American companies to pull back.

The targeting of the American precision optics base by the Asians have caused severe erosion of our industry, forcing a tightening and a cutback throughout the manufacturing community.

R&D which was originally funded by American corporations has been slowly withdrawn in direct proportion to the erosion of the manufacturing base, providing the Japanese with the opportunity to seek out universities which would accept their funding.

We believe that if the recommendations which are made here could be implemented, our industry would again return to its former position as a healthy, productive national asset. Thank you.

Senator BINGAMAN. Thank you very much. I think we will just hear from the other two witnesses before I interrupt to ask other questions.

Mr. Bennett, we are glad to have you here.

STATEMENT OF THOMAS E. BENNETT, PRESIDENT, THE TORRINGTON CO., AND CHAIRMAN, ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION

Mr. BENNETT. Thank you, Mr. Chairman. My name is Thomas Bennett and I am president of the Torrington Co., and I am currently serving as chairman of the Anti-Friction Bearing Manufacturers Association, which by the way makes all types of bearings, not just ball bearings.

I shall inform you when any of my remarks are made as the AFBMA chairman. Otherwise, my comments are on behalf of the Torrington Co. Joining me today is Mr. Harold Brodsky, retired president of the Fafnir Bearing Co. Mr. Brodsky is a graduate of MIT and 40 years in the ball bearing business.

Mr. Michael Paine, president of the AFBMA, and Mr. Dick Harwood, of the Torrington Co., are here to assist me should you have any questions that I could not handle.

I sincerely appreciate the opportunity to speak to you briefly on the status of the domestic bearing industry as it relates to the national defense concerns, and about the filing of a section 232 petition by the AFBMA.

The Torrington Co. is a wholly owned subsidiary of Ingersoll-Rand Co., with 12 bearing plants in the United States, three in England, one in Brazil, one in Australia, one in Canada, and joint ventures in Italy, France, and Japan.

This worldwide presence has provided us with a solid foundation of knowledge and experience in international bearing manufacturing and sales practices and policies.

I see an urgent need to promptly address and answer three basic questions in regard to the domestic bearing industry and its strategic role not only in national defense, but in support of America's industrial competitiveness.

First, is it a critical national defense industry? The answer is yes. The recent Joint Logistics Commanders Study concluded just that. While the industry is not alone in this posture, nothing would bring the defense operations of this country to a halt any faster than a lack of bearings.

Any mechanized equipment, whether on land, sea, or in the air will cease to operate after failure of a critical bearing. One need only to look back at Allied efforts during World War II to destroy bearing plants, and the priority placed on rebuilding bearing capacity in post-war Europe and Japan, to understand the critical importance of this industry.

Second, can the domestic industry presently supply mobilization needs, and if not, can the country rely on imports to fill the gap? All existing studies and opinions that I am aware of, including the recent DOD analysis, conclude that the domestic industry cannot presently meet such demands and the gap is substantial.

As to whether imports can be depended upon to fill the gap, I believe there is a rather significant difference of opinion. The Joint Logistics Commanders said no. My own opinion is no.

Importers certainly have the skill and the technology to make up any deficiency. Whether they have the capacity involves, among other things, the question of whether in any mobilization period our suppliers of imported bearings would have their capacity equally taxed by their own country's mobilization needs and whether they would be in a position, logistical, political, or otherwise, to fill our needs.

Until a mobilization actually occurs, no one can answer the question of how much we can depend upon imports. But right now we can answer the question of whether this country can afford the risk of a mistaken reliance on bearing imports.

In light of the inevitable disastrous consequences of an unjustified dependency on imports, I see a clear and unavoidable obligation of this country to assure itself of a domestic bearing industry capable of fulfilling critical defense bearing needs.

If our decision to rely substantially on imports is wrong, then there will be no time for a cure. There will be no second chance. Expansion of capacity to make critical, high precision bearings is a task that would take years to accomplish.

Third, what actions and conditions are necessary for the industry to be able to meet these needs? A thorough analysis of the extent of the shortfall in the domestic industry's total defense capacity, and the conditions which have led to this situation, are necessary before an intelligent solution can be adopted.

Before giving my personal recommendation and that of the majority of the members of the AFBMA, I want to give you just a few facts establishing how critical the situation is, and how great an in-

crease in production is required to satisfy a standard of domestic capacity to meet mobilization needs.

In 1986, imports supplied 64 percent of U.S. consumption of ball bearings, 40 percent of consumption of tapered roller bearings, and 17 percent of other roller bearings. Every indication is that roller bearing imports will reach the ball bearing market share.

Domestic industry capacity is decreasing steadily. An unrecognized but highly influential factor is the market loss due to the tremendous increase in the importation of products having significant bearing content which were previously produced in the United States.

Cars and farm and construction equipment are the most obvious, but hardly the sole illustration of this major cause for the reduction of U.S. bearing capacity.

Industry profits have been inadequate to warrant substantial expenditures for modernization. The Joint Logistics Commanders Study showed that bearing producers having sales of under $30 million earned only 0.3 percent profit. Those with sales over $100 million earned 2.4 percent.

It is obvious that companies with such low returns cannot generate the investments required, and that their very survival is at risk. In considering the appropriate remedy for this problem, the following points should be kept in mind.

It has been asked, what differences exist between foreign government/industry relations in foreign countries and those in the United States. The Japanese do not have specific laws or regulations targeted toward special assistance to the bearing industry. They do not need to.

The reason is that the government/industry culture is such that policies and practices established in the early 1950s now self-operate, propelled without any other stimulus than long-established policies and practices.

To cite just a few examples, users of bearings, without the need of government regulation, purchase non-Japanese manufactured bearings only if it is not available from a Japanese supplier.

In the rare event that a competitive foreign-made bearing, the import authorizations are never issued until the need is passed. The application simply never gets processed.

Banks provide special rates to any domestic applicant. The foreign supplier requiring domestic financing finds he has a significant higher rate.

The Japanese Government recently financed an extensive worldwide competitive analysis of the bearing industry, which was made available to all Japanese bearing manufacturers. The cost of such a comprehensive study could be afforded by few, if any, U.S. producers.

And I cannot conceive of our Government undertaking an equivalent survey for the free use of a domestic industry. To a lesser degree, similar non-regulatory use-oriented practices exist in Europe.

In Germany, preference for domestic suppliers is strong and effective. As in Japan, the preference is traditional. The only regulatory example we can provide is an Italian prohibition against imports of any Japanese bearings.

In France, much of all of the industry, including bearings, has been government-owned. And government policy automatically becomes industry practice. I think you can see from this that foreign bearing manufacturers are justified in feeling a sense of unity of purpose and effort between their governments and themselves.

In contrast, in the United States, the bearing industry, no different from almost any other industry, must devote a very substantial part of its attention and finances to simply complying with the laws of existence.

I refer to laws and regulations such as those governing issues of environmental matters, ERISA, workers' compensation, unemployment insurance, age, sex, handicap, veteran benefits and rights, and anti-trust laws and regulations.

And I do not dispute the appropriateness of such laws or regulations. We totally endorse and support their objectives. They are, however, a fact of business life. A truly impressive cost is imposed on U.S. manufacturers simply to comply with such socially desirable objectives.

We point out that they create governmentally mandated operational costs of significant proporations that are inescapable for the U.S. producer but are not equally borne by our foreign competitors in either domestic or export sales.

The U.S. industry, and I think this is important, the U.S. bearings industry is technologically competitive, in fact, in a leadership position on special application for jet engines, missile guidance systems, et cetera.

We are capable of competing on the high volume production sizes for bearings on every basis except labor costs. These social cost differences must be recognized in the development of a strategy and the implementation of government policies in support of our industry.

Foreign pentration of our markets has been primarily on the high volume sizes. There is little doubt that some governments have recognized the significant contribution bearings can make to industrial competition.

After World War II, the Japanese decided to develop an industrial society. And they recognized at that time that bearings would be a critical success component of such an effort.

So the Japanese Government, I think to their credit, took action to develop a strong bearings industry. In fact, the Japanese attribute the success of their automotive industry to the quality of their bearings.

Why do I know this? Because I have video tapes of a nationally televised Japanese television program in which the commentator makes those statements.

Focused high volume production, coupled with significant labor cost advantages for many years has greatly eroded the foundation of the U.S. industry. The U.S. industry cannot continue to provide the special designs and high tech products without the underlying support of the high volume market.

The domestic industry should probably have been more aggressive in instituting dumping actions, when there is reasonable evidence of its occurrence. Many companies simply cannot afford the cost.

In the past, it seemed that the government was not an enthusiastic supporter of such actions, but this appears to have changed in the last year. We have seen determination of dumping duties in 9 months.

We applaud such prompt government action, and we recommend it continue. And I want to emphasize, however, that dumping actions, even if universally successful, will not create the necessary defense capacity. They will only stem erosion.

There is much the industry can do in the nature of self-help. There is still more than can be accomplished with programs such as have been proposed by the DOD in its Bearing Action Plan submitted to Congress on March 24, 1987.

The proposed FAR regulations, requiring domestic content to the extent available, will be of significant assistance. But since DOD purchases only about approximately 17 percent of U.S. bearing consumption, it is obvious that this alone cannot create the required defense capacity.

As a country, we seem at times inclined to shoot ourselves in the foot. Bearing steel, for example, is not ordinary steel. It has very special characteristics. When steel quotas were imposed, they included all forms of bearing steel.

Whenever any type of bearing steel had its quota exhausted by other types of general use steel, it has one or more of the following consequences. One, it gives an importer a significant material cost advantage.

Second, the domestic bearing producers are compelled to import semi or totally finished parts, depriving U.S. bearing manufacturers of the production.

And third, domestic producers probably lose the orders due to lack of material or become non-competitive due to increased material cost, and are forced to rely on a competitor for raw material.

None of these results seems rational when you consider that the bearing steel that we are talking about amounts to only a small fraction of 1 percent of total steel production in the United States. Inclusion of bearing steel in the quota helps nobody and hurts domestic bearings.

As another illustration, we wonder why we aid in the erosion of a strategic industry by continuing to allow bearing imports from non-market countries whose main interest is in earning dollar exchanges and who are likely to sell their product at any price.

So what do we produce? We are not aware of any other industrialized country in the world that would hesitate for 1 minute to undertake the action necessary to assure the maintenance of an industry so critical to its national defense.

In our opinion, for the United States, that action is a quota system, a quota system which would be subject to modification and adjustment according to the industry's response to the capacity opportunities made available to it.

If the industry develops to the extent it can stand on its own, the quota can be relaxed or lifted. If the industry fails to respond to the opportunity, and if imports for civilian or defense needs can be met only by increasing or eliminating quotas for that item, such action should also be implemented.

At the same time, the Bearing Action Program proposed by the DOD must be implemented and given strong support by the domestic bearings industry. Certainly quotas are not the whole solution and will not in and of themselves create the bearing industry this Nation needs.

They would, however, provide an opportunity to being the industry's recover. After much study and debate, the Anti-Friction Bearing Manufactuers Association membership has authorized the filing of a section 232 petition which explains in detail the justification for such a quota system.

A copy of the summary section of the petition is attached to my written testimony, and a full copy of the petition has been provided for the committee's information. As AFBMA chairman, I want to state for the record that the filing of the petition and the recommended remedy are not unanimously supported by the members.

Those who oppose it are indentified in the petition. From my position as president of the Torrington Co., I believe it should be noted that AFBMA members identified in the petition as being opposed to the petition are all foreign-owned.

I would close by stating that three independent studies by government agencies have concluded that our industry is vital to the defense interests of the United States. It is important for our country to have a clear understanding of government policy with respect to our industry.

What is at stake here is not only the capacity to meet mobilization needs but the ability of the industry to provide ongoing bearing technology to U.S. industry to enable it to develop high performance products necessary to overall industrial competitiveness.

If we have such a policy, I am not aware of it. We have to have this information as an industry to guide our future decisions, particularly those decisions regarding investments.

That is, in part, what we are seeking with the filing of a section 232 petition, and we are anxious to see what the coordinated response of the responsible government agencies will be. Thank you.

Senator BINGAMAN. Thank you very much for your testimony. Mr. Gilbert, we are glad to have you here, and look forward to your testimony.

STATEMENT OF CHARLES E. GILBERT, JR., PRESIDENT, CINCINNATI GILBERT MACHINE TOOL CO., AND CHAIRMAN, NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

Mr. GILBERT. Thank you, Senator Bingaman. Good morning. My name is Charles E. Gilbert. I am president of Cincinnati Gilbert Machine Tool Co. of Cincinnati, Ohio. I am also chairman of the Board of Directors of the National Machine Tool Builders' Association, NMTBA, on whose behalf I am appearing today.

NMTBA is a trade association representing more than 300 companies. With me this morning are James H. Mack, NMTBA Public Affairs Director, and Charles P. Donner, NMTBA Industrial Preparedness Representative.

The U.S. machine tool industry is small. However, the products and technology of this industry are the essence of the industrial

manufacturing process and the keystone to an effective industrial base.

Even in peacetime, up to 25 percent of the Nation's total consumption of machine tools is linked directly or indirectly to defense requirements. History teaches us, gentlemen, that if war erupts when the domestic machine tool industry is weak, effective military mobilization is delayed for many months. These delays would directly and gravely impair the national security.

Our written testimony documents the heroic measures America's machine tool builders are taking to maintain our technological lead and to remain competitive. However, the U.S. machine tool industry has been crippled by a flood of subsidized imports.

In 1986, imports measured by value accounted for 49 percent of the domestic machine tool market. Twenty-five percent of America's machine tool capacity has either shut down or moved offshore since 1983.

In its present condition, the U.S. machine tool industry could not adequately support and sustain U.S. defense requirements, should we become involved in a global conventional conflict of extended duration.

The risk of becoming dependent upon foreign sources for machine tools has become unacceptably high, and that risk has been increased by our own Defense Department. In the last 5 years the procurement of foreign made machine tools for use in Department of Defense facilities has dramatically increased.

If this trend had been allowed to continue, the major portion of the most modern and defense-sensitive machine tools in these facilities would have been foreign.

Last year Congress adopted an amendment to the Defense Appropriations stating that fiscal year 1987 funds cannot be used to purchase, for use in DOD facilities, 23 Federal supply classes of defense-sensitive machine tools from sources other than the United States and Canada.

We urge the Congress to continue these restrictions during your consideration of the Department of Defense fiscal year 1988 appropriations bill. I understand a permanent restriction is included in Senator Dixon's proposed bill to improve the defense industrial base of the United States.

On May 20, 1986, in response to our 232 petition, the President announced his decision to seek voluntary restraint agreements, VRAs, on machine tool imports from Japan, Taiwan, and various other countries.

VRAs have been successfully negotiated with Japan and Taiwan. But merely limiting imports will not do the job. A major commitment of resources is needed to foster the industry's growth.

Although R&D in America's machine tool industry is already growing at 6 percent annually, most machine tool companies are very small, and joint action among them and their customers is needed.

Therefore, NMTBA members and their customers have formed the National Center for Manufacturing Sciences. President Reagan has directed the Defense Department to provide up to $5 million per year through fiscal year 1990 in matching funds for the National Center.

A major thrust area for machine tool development has been established within the Air Force Manufacturing Technology program, MANTECH. This effort is considered to be of vital importance to the revitalization of the U.S. machine tool industry and the defense industrial base.

The administration has proposed funding the President's Machine Tool Domestic Action Plan through a $35 million annual increase in the Air Force MANTECH Program. Congressional approval of this request is critical, and we commend this committee for including it in the fiscal year 1988 Defense Department Authorization.

There are several programs within the Department of Defense that have the potential to make major breakthroughs for improvement of the industrial base. Funding for the MANTECH Program should be significantly increased.

The IMIP Program should also be substantially increased. Indemnification of contractor's procurement of machine tools should apply only to equipment manufactured in the United States and Canada.

The Department of Defense, in coordination with other government agencies, should make aggressive use of the Defense Production Act to help preserve the defense industrial base.

The Department of Defense should promote contractor investment in new, domestically produced equipment by making the degree and type of modernization planned by defense contractors a significant factor in determining the contract awards.

Dual sourcing of critical defense items should be used to maintain domestic sources of supply. To help preserve domestic sources of supply for critical defense items, contracts that are available to foreign contractors should mandate that a major portion of the work be subcontracted to U.S. firms.

Where it is documented that a foreign firm has followed unfair trade practices, action should be taken to debar or suspend that firm from future Defense Department business. Such actions, as a foreign firm's violation of the COCOM regulations, should be grounds for debarment or suspension. The recent Toshiba case is a good example.

A finding that a manufacturer or a distributor of foreign equipment has falsified the foreign content of a product or provided false written certification that a machine meets all contract specifications, should also constitute grounds for suspension of debarment.

There are numerous instances where such violations have occurred in recent years in defense procurement of foreign machine tools. To help preserve the remaining U.S. machine tool industry, other actions are needed beyond those that are within the jurisdiction of this committee.

The capital cost recovery system must be improved. Last year's Tax Reform Act placed our industry and its capital-intensive customer base in a very precarious position.

At the very least, we urge you and your colleagues on the Finance Committee to look beyond capital-intensive industries as you search for ways to raise new revenue pursuant to the budget resolution.

We believe that the time has come for adoption of meaningful revisions in the U.S. trade laws, and we commend you for the overall thrust taken during Senate floor consideration of the Omnibus Trade bill.

For example, Senate bill 1420 clearly defines and recognizes foreign export targeting as an unfair policy or practice that is actionable under section 301 of the Trade Act.

The Senate has also made substantial improvements in national security import laws, section 232, and in the Export Administration Act.

The current product liability system is another serious impediment to the productivity and competitiveness of U.S. machine tool manufacturers. The current product liability system fosters confusion, unfairness, and wasteful transaction costs.

Our written testimony documents that in 1984, American industry spent more money to hire lawyers to defend them in product liability lawsuits than they spent to buy new machine tools to improve their productivity.

Enactment of a uniform Federal product liability statute will stabilize insurance rates, and substantially reduce transaction costs. A development which unquestionably will allow domestic manufacturers to compete more effectively in this country and abroad.

I firmly believe that a nation cannot be a first-rate military power with a second-rate industrial base. The Soviet Union recognizes this, for they are giving first priority to their machinery sector, which continues to realize the most rapid growth in the entire Soviet economy.

We must take action to improve the responsiveness and competitiveness of our industrial base. The continued deterioration of the manufacturing sector of our industrial base will not only reduce our ability to support our military forces, but will also destroy a credible deterrent and will ultimately lower the standard of living of every American.

Action is needed, and it is needed now. Thank you, Mr. Chairman. I would be pleased to respond to any questions.

Senator BINGAMAN. Thank you very much. Let me ask a couple of general questions, and any of you who would like to could respond to them.

Dr. Kelly was talking about the disparity or the differences that he saw in the attention that our industry gives to manufacturing processes, as compared to the attention that, in the cases he was citing, the Japanese have given to that.

To what extent do you think our failure to upgrade and modernize our manufacturing processes in each of your industries has been a factor in the loss of market share that has occurred?

I will start with you, Dr. Leshne, if you have an opinion on that. Is this a part of the problem, or is this in your view not a serious problem?

Dr. LESHNE. It is a part of the problem, Mr. Chairman. It is not the entire problem. I do not believe that the Japanese produce better optical components than the Americans produce.

They produce as good, and in that respect I cannot agree with Dr. Kelly that they take more attention to their finished products than we do.

Senator BINGAMAN. Do they produce them more efficiently, at a lower cost?

Dr. LESHNE. No, sir. They are at a lower cost because of various other things we have talked about.

Senator BINGAMAN. Because of the over-regulation and the wage rates, primarily, as I understood your testimony?

Dr. LESHNE. Yes, sir.

Senator BINGAMAN. But you do not think that additional attention to the manufacturing process would significantly improve the ability of the United States, your segment of the U.S. industry, to compete?

Dr. LESHNE. I do. I do feel that we have a lot of improvement to make in our industry. However, today, our industry with the equipment we are using compares very favorably with that of the Japanese and the other people in Asia who are undercutting our prices.

However, the Optical Manufacturers Association is undertaking a program, as I mentioned, to produce new and dedicated automated equipment. We have never had automated equipment in this industry.

We have always taken equipment that the machine industry used, or the opthalmic manufacturing industry used, and modified it to the precision optics people. But we are about to change that with our new generator coming up.

We feel that even if, and we are sure that the Japanese will copy the machine, and so will the rest of the world, but at least it will be a one on one basis. Where when the Japanese need three people and we need three people to produce a lens, at a certain point in the manufacturing process, the margin of price differential is tremendous.

However, if they need one person and we need one person, that narrows it down. And that makes it a more competitive situation for us. And that is our aim.

Senator BINGAMAN. So you are saying by developing this new lens generator that you discussed, you are able to reduce the importance of the differential in wage rates.

Dr. LESHNE. That is correct.

Senator BINGAMAN. And although the foreign competitors will clearly have this new generator very quickly, they will still lose some of the advantage that they presently enjoy, because there is so much more labor involved in the production.

Dr. LESHNE. Yes. That is exactly it. The lens generator is just the first step in our plans to automate our industry. When we automate our industry, we will probably be automating the industry throughout the world.

That is okay. We recognize what we have to do to become competitive on a world basis, and we are taking those steps. But we do need help.

Senator BINGAMAN. You do not believe the manufacturing processes you presently employ are any less efficient or are any less productive than those employed by the Japanese or any foreign——

Dr. LESHNE. That is exactly correct.

Senator BINGAMAN. One specific issue that Dr. Kelly referred to was the inventory as a factor that increases the cost of production

in that country, and the complexity of our production processes that the Japanese do not have to contend with because they work toward no inventory.

Is that a factor in your industry or not?

Dr. LESHNE. No. In the precision optics industry, and especially for DOD contracts, there is no inventory per se. Our inventory is work in process. We buy enough materials for a specific job, and we finish that job, and we have no usable materials left over.

When people generally think of inventory, they think of something on the shelf, and when a customer calls up, they ship it right out. That is not the case in the precision optics industry.

Senator BINGAMAN. OK. Let me ask Mr. Bennett the same kinds of questions, if you would please.

Mr. BENNETT. I would like to comment on that. In the bearings, industry, you have really two main elements. You have high volume standard, commodity type bearings, and you have special design bearings of all descriptions. And it is in high volume types that we have lost our edge.

In the specials, I think that from the point of view of process capability and technology and efficiency, we are world class.

In the high volume sizes, the strength exhibited by particularly the Japanese, but also the Germans and the Swedes, comes from 20 or 30 years of having significant cost advantages and having a tradition in bearings.

The Japanese, the Germans, and the Swedes, who invented the ball bearing back at the early turn of the century, have been in the bearing business a long time. I think all three of those well developed industrial societies have a predilection for precision. They are good at manufacturing precise things.

Following the war, they had a significant cost advantage, and during this time went down the learning curve in building automated processes for producing large runs of standardized product.

And I think that the big edge that the Japanese have been able to create for themselves is something that Dr. Kelly addressed. And that is the quality aspects. They have virtually eliminated scrap and re-work from their manufacturing process.

Now, we are not standing still in this regard. We are very hard at work in this country doing the same thing, and I have been in bearing plants in this country where I have seen world class results in that regard.

The Torrington Co. has invested in a manufacturing development center in Georgia. We have assembled in this center 50 of our top engineers, and we are probably going to go to 75.

And the mission of these engineers is to be aware of and to assimilate world class technology on an accelerated basis in all of our plants. We have made a very substantial commitment to the process side of the business.

Senator BINGAMAN. Is this industrywide or is this your company?

Mr. BENNETT. No. This is our company. So I think that the Japanese do have an advantage. They have done a very good job in dealing with the quality side of the business, and created an environment that is substantially ahead of where most American companies are today.

Some companies, like Xerox for example, have done an amazing job in closing the gap. There are others. And we are hard at work doing the same thing.

Senator BINGAMAN. Let me just ask, before we move to Mr. Gilbert with this question. In the machine tool industry they have this combined program to pursue manufacturing processes between the various companies. Do you have any combined effort going on in your industry? or is this just company by company?

Mr. BENNETT. It has been company by company, and it remains that way. There is support within the industry for the National Center.

For example, there has also been discussions among interested companies in the New England area to create a center of expertise at the University of Connecticut for grinding.

We know that in Europe, particularly in Germany, the universities are very much in liaison with the manufacturing companies on important technological matters. And we are trying to emulate that.

We, as a company, have been talking with five or six other companies, including United Technologies, the Norton Company, five or six companies in New England about funding a technological center at the University of Connecticut directed at improving our grinding technology, which is a critical technology in the manufacture of bearings.

So, I would predict that more of this is going to happen in the future, although it has not happened up till now.

Senator BINGAMAN. OK. Mr. Gilbert.

Mr. GILBERT. Senator, to go back to your original question, I believe you asked about the manufacturing engineers, in effect, and our association and its members are concerned by the reduced number of manufacturing engineers we find in our customers' plants.

I would agree with your comment that probably these people provide a lot of impetus for the purchase of new machine tools and for improved processes generally in manufacturing.

We have got to get more people into our engineering schools and get them out into manufacturing. Our association has initiated a scholarship program, which, when you look at U.S. industry, is small, but at least it is a start. So we do recognize the problem.

In addition to that, of course, we have to do more, and there are three things. One is to reduce the cost of capital and increase access to it. Or we are going to have to provide guarantees of markets, which we do not find too attractive.

We unfortunately seem to be moving in the wrong direction on all three fronts. We would welcome and we do know that the bearing industry is participating in the National Center.

And we would undertake in the National Center manufacturing research for the bearing manufacturers. That is the idea of the thing.

Senator BINGAMAN. Let me ask you, on your National Center for Manufacturing, what is the status of that at this point? Is it up and functioning? Is it anticipated to be functioning at a certain date?

Mr. GILBERT. We expect to have it actually functioning in November, I think, is the latest date. We are in the process of narrowing down the selection of a site.

We have been presented with a number of offers by various states and we have narrowed it down, I believe, to four. I have been involved in this thing from the very beginning, but I am not terribly active in the picture.

But we are now, this summer, undertaking a selection of research projects to be started initially by the Center. The Center will actually do no research of its own. There are plenty of organizations throughout the country who actually do the research.

We will be sort of a clearinghouse. We will place contracts for research, requested by our members. In some cases a consortia of members. Or in other cases, just individual members.

We also want to be able to determine what research has been done, what results are available, so that we can disseminate this information throughout the industry. That has been one of the big problems.

There has been so much activity going on, and yet the people who could use it are not aware of the results, and have a very hard time getting the results for their own use.

Senator BINGAMAN. You anticipate $5 million per year from DOD for the operation of the Center. Is that what you testified?

Mr. GILBERT. Yes.

Senator BINGAMAN. How much is industry contributing?

Mr. GILBERT. We expect to have a budget of $50 million a year.

Senator BINGAMAN. So the other $45 million will come from industry?

Mr. GILBERT. Will come from industry, yes. We have tried to keep the thing from being dominated by machine tool builders. That is not the idea of it. We really want it to be dominated by our customers.

Senator BINGAMAN. How do you manage this Center? Is there a board made up of machine tool companies' representatives? Or who is on this?

Mr. GILBERT. There are two boards. There is an overall board, which will oversee the general management of the Center.

This will be made up of chairmen and presidents of large companies, such as General Motors, General Electric, and ones that we can get. And it will be an overseeing type thing.

And then there will be an active board which will select the projects to be worked on on recommendation from the research committees. There will be a managing director. We have not selected him yet.

We have now moved into our own offices, and we have only three paid employees. We expect when the thing is going that we will only have 50 employees. It is to be a clearinghouse, a placer of contracts.

Senator BINGAMAN. Is there a significant foreign-owned machine tool manufacturing presence in this country today?

Mr. GILBERT. Yes, there is.

Senator BINGAMAN. Are they going to be part of this Center?

Mr. GILBERT. No.

Senator BINGAMAN. So any machine tool manufacturer in the country that is foreign-owned would not be permitted on the board or to participate in the research.

Mr. GILBERT. That is the plan at this time. Yes, sir.

Senator BINGAMAN. Which foreign companies are active? Are there a few large foreign companies that manufacture machine tools in significant quantities in this country?

Mr. GILBERT. Yes. White Consolidated Industries is now owned by Electrolux. Yamazaki, or Mazak, has a good-sized plant in Florence, KY, a Japanse outfit.

Giddings & Lewis is owned by a Canadian company, and they would be included, as far as I know. Leblono Mikino is owned by the Japanese, and they would not participate. Toyota is another one.

Senator BINGAMAN. On another sort of general question for any of you who would like to respond.

The concern, of course, that is always raised when we go to some proposal for DOD to buy American, to keep our industry in business in a particular area, is that this will in fact shield our industry from the competitive forces that would otherwise force us to modernize. Therefore we sort of build in a position of inferiority for our own industry by giving our industry that exclusive market. Now, I would be interested in any of you commenting as to whether you see validity to that argument or how we guard against it.

Dr. LESHNE. If I could start off, Senator. If the precision optics industry does not have a Federal Acquisition Regulation in the next 2 to 3 years, there will be no precision optics industry or base in this country at all.

The people that are needed for this industry, as I said, are retiring and moving. These people are not college graduates. They are people that have gone through apprenticeship training programs in Europe. We need such a program in this country. These people can help us with this type of program.

If we did have a Federal Acquisition Regulation for precision optics, which we do not have now, if we did have this, we would pursue the same programs that we are pursuing now.

We talked about what APOMA, which is the precision optics manufacturers' association, is doing on its own. A new generator, a new machine. Never before in our industry has there been anything like it.

We are taking the initiative. We have set up a syllabus for a training program. We again are taking the initiative, with our fingers crossed that there will be a Federal acquisition regulation governing precision optics. Because if there is not, all of this is for nothing.

Senator BINGAMAN. You believe that your incentive to take the initiative, and move forward in modernizing your processes and keeping your costs down would still be there even if you had an exclusive market in DOD?

Dr. LESHNE. That is the incentive for us, a Federal acquisition regulation or a market for our manufacturing capability. That is our incentive, to better our industry and make it more competitive, to modernize it.

Senator BINGAMAN. If there is a Federal acquisition regulation imposed, should it be limited to a certain period of time after which we would anticipate the U.S. industry being capable of competing again with foreign——

Dr. LESHNE. Yes.

Senator BINGAMAN. What time period?

Dr. LESHNE. A 7-year period.

Senator BINGAMAN. Why 7 years?

Dr. LESHNE. The Joint Logistic Commanders Study found that if we had a 7-year period, the first 2 years of that period would require the DOD to purchase 50 percent of the optical components which are to be domestically manufactured. Only 50 percent.

The DOD could still buy 50 percent of its optics offshore. But they are assuming that 2 years would give our industry the impetus and the wherewithal to be able to supply 100 percent for the last 5 years.

Now, producing 100 percent of the DOD's optics for 5 years would enable us to have enough trained opticians in our training program, that it would take that long, and enable us to continue our research programs to modernize our industry.

Once we have gotten to that point, we will stand on our own against any nation.

Senator BINGAMAN. You believe that you would be able to compete in the commercial market at the end of that 7 years?

Dr. LESHNE. Yes, sir.

Senator BINGAMAN. At the present time, what percentage of the commercial market do you have?

Dr. LESHNE. Zero.

Senator BINGAMAN. Zero. But you think you could compete in that market after 7 years?

Dr. LESHNE. Yes, Senator. The Department of Defense is the major purchaser of precision optical components. If that market is utilized fully by American manufacturers, it takes a big chunk out of the rest of the Far East's market.

They are going to have to increase their prices to make up the loss of business. We are going to modernize, and we are going to bring our total differences down. We will be able to compete on the commercial basis.

Senator BINGAMAN. Mr. Bennett, did you have thoughts as to whether there is a danger of us institutionalizing an industry that is non-competitive by giving them this kind of an exclusive market?

Mr. BENNETT. In the first place, I think it is important to realize that what Dr. Kelly said is moving generally in the right direction.

I would say that right now I do not see any reason why we as an industry can not compete with Western Europe or, particularly Germany, or with Japan, given current exchange rates, and provided we get the required infrastructure.

The difficulty is that these exchange rates are so volatile that 3 or 4 years from now we could be looking at 240 yen to the dollar and everything has gone the other way on us. But at current exchange rates, we should be competitive.

What has happened in our industry, though, is that this high volume production has eroded to the point where it is virtually

non-existent or inefficient in this country. And it has gone offshore, initially to Japan, and it is moving now to some extent even outside of Japan.

It is questionable in my mind as to whether or not the Japanese will be able to compete in the long run on this high volume side. For example, one of the major producers in the world of small miniature bearings has developed a world class manufacturing capability with every major modernization put in the plant in Thailand.

And in Thailand you can have a worker for a month for 48 hours a week for $78. Similarly, we see competitors, bringing in products from Poland or Yugoslavia or Romania.

Last year at current dollar exchange rates, the real cost of labor in Poland was $75 a month. So I do not see in the case of the commodity, high volume range of bearings that we are ever going to be able to compete on that basis.

There is no way we can make the machinery that different to overcome those differences in labor costs. Unfortunately, it is the high volume commodity sizes that the country needs the most of in a general mobilization. So we have that tradeoff to consider.

The market size in terms of value is relatively small. If you took the total imports of ball bearings as a group you are talking perhaps $500 million or $600 million. Let us say that half of that is commodity, you are talking $300 million.

And if the price was affected by 10 percent and I am not sure it would be, you are talking about $30 million as compared to the alternative, which is to not have a secure, viable industry to support a general mobilization. So I think that economically it is a nonevent.

But I do not think that in the high volume, production sizes, where you can go out and you can buy for some millions of dollars the production methods that the USA can gain a productivity edge. These production systems are for sale, and in every developing country, one of the first things they put in is a commodity bearing production line.

Indonesia put one in 2 years ago. That is one of the first things a developing country does to get some indigneous capability for bearings. This usually results in excess capacity, and somebody goes over and gets a contract from these people and they sell their excess capacity in this country.

We talked about dumping, it has been very difficult to get facts on. We have had some people working on that full-time for the last 7 or 8 months.

I do feel at this point that we as a company are going to be more active in bringing potential dumping cases before the government. We expect, based on recent performance, that the government is going to be supportive in making a determination whether dumping is going on, and perhaps that might help.

Senator BINGAMAN. Mr. Gilbert, did you have any thoughts on this problem of whether we can keep our industry competitive if we require DOD to purchase nothing but American products?

Mr. GILBERT. We are talking now about machine tools?

Senator BINGAMAN. Right.

Mr. GILBERT. The VRAs have a definite lifespan, I believe, of 5 years. So if the industry is too obnoxious, we will get knocked off. And I think those are reviewed on a yearly basis.

The Department of Defense regulations, so far, are on a yearly basis. We would like to see them made permanent. But in our company history, we have always had a lot of competition, and most of them are still there.

So that we cannot do a whole lot about our prices and in fact our prices are 1982 prices. And if you came along this afternoon and wanted to buy a machine from me, I would probably cut the price 10 percent without batting an eye.

But that is not a healthy condition. I think there will be some people who may try to take advantage of it, whether it would be successful or not, I do not know. But I do not think it would be a problem.

Mr. BENNETT. Could I add just one thing? Following up on Mr. Gilbert's statement there, much of what the DOD buys now is not available overseas.

Some products are not generally available, although international competitors are trying to develop their capability. For example, the bearings with respect to high performance jet engines.

Well, I can tell you the environment for that business is very competitive within our own economy. DOD bearing purchases are about 17 percent of total U.S. consumption.

And much of that, most of that, I would say, is under very, very competitive conditions as it stands now.

Senator BINGAMAN. Well, gentlemen, thank you very much. As we go forward in the next few months, these are issues that we want to continue to look at in the subcommittee and decide what the proper role of the Department of Defense is. We appreciate your testimony very much.

I think it has helped us to understand the problems that your particular industries are facing. Thank you. We will now adjourn. We hope to have more hearings this fall on the same issue.

[Whereupon, at 11:30 a.m., the hearing was adjourned.]

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